this paper. Donald R. Davis, U.S. National Museum, loaned two specimens of *Caloptilia rhoifoliella* to the author. Jerry A. Powell kindly reviewed the manuscript of this paper.

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The Development of *Cactobrosis fernaldialis* and *Albareda parabates* in Relation to Temperature[1]

(Lepidoptera: Pyralidae)

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Cactobrosis fernaldialis (Hulst) is the most important known vector of the bacterial disease, *Erwinia carnegieana* Standring, of the giant cactus or saguaro, *Cereus giganteus* Engelm. (= *Carnegiea gigantea* Britt. and Rose). Butler and Werner (1965) gave light-trap records for this species as well as *Albareda parabates* (Dyar) and *Cahela ponderosella* (B. and McD.), which are also cactus-eating moths, Boyle (1949) observed *C. fernaldialis* in the field and laboratory and concluded that there was but one generation a year. Eggs required 30 days to hatch, the larval stage in the giant cactus lasted from November to May, and the pupal stage was from 28 to 33 days. The present study indicates that the

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life cycle of this insect is considerably different when feeding on semi-synthetic media in the laboratory. These results also provide information to predict the rate of development for rearing programs, for estimating low and high temperature thresholds of development, and to use as a major input for computer simulation of population fluctuations.

METHODS AND MATERIALS.—Larvae of *C. fernaldialis* were collected from saguaro buds in early June, 1966. They were placed in individual 1-oz. paper cups containing a lima bean-agar medium developed by Shorey (1963), which is used as a standard laboratory diet for bollworms, cabbage loopers, salt-marsh caterpillars, and other larvae. The cups were placed in a plastic bag in a 1-ft^3 wire cage. The larvae chewed holes through the cups when full-grown and crawled out. Some spun cocoons between the cups while others chewed their way out of the plastic bag and pupated in the corners of the cage. Moths were held in 1-qt cartons with a 1-dr vial of sugar-water in the lid. A strip of 32 × 32-mesh saran screening was placed in each carton on which most of the eggs were laid. The eggs were removed daily, held in constant temperature cabinets, and examined daily for hatching. First-instar larvae were placed in 8-oz cups of media until about half-grown and then transferred to individual 6-dr cotton-stoppered shell vials. They were held at different constant temperatures and examined daily to determine when they pupated and when adults emerged. Several generations were reared in the laboratory.

Constant temperature cabinets were maintained at 68°, 77°, 81°, 86°, and 95°F and thermoswitches held the temperatures to ± 2.5°F. Humidity was held near 50%. Lights were on for a 15-hr period each day starting at 6 A.M. A regression equation, $\hat{y} = a + bX$, where $\hat{y}$ is the reciprocal of the duration of a stage and X is the temperature, was calculated for the different periods of development, as discussed by Butler (1966). Fahrenheit temperatures were used to permit calculation of developmental time using U. S. Weather Bureau data. Transformation of the regression equations to Celsius can be made according to Zar (1969).

RESULTS.—The duration of the egg stage of *C. fernaldialis* was 9 days for one group of eggs at 68°F, 4 and 5 days for 2 groups of eggs at 77°F, and 3 days for 6 groups of eggs at 86°F. The duration of the larval and the larval-plus-pupal stages at different temperatures is given in Table 1. The larval stage varied from 34.2 days at 68° to 22.2 days at 81°F and increased in duration as the temperature rose above this point. The regression equation for the larval stage between 68° and 81°F is $\hat{y} = 0.00124X - 0.0547$ ($r^2 = 0.99$), where $\hat{y}$ is the reciprocal of the duration

TABLE 1. The mean duration of the larval and the larval-plus-pupal stages of *Cactobrosis fernaldialis* in relation to temperature.

Temperature °F	Larval stage			Larval-plus-pupal stages		
	No. individuals	Mean no. days	± SD	No. individuals	Mean no. days	± SD
68	23	34.2	± 10.6	19	57.4	± 11.2
77	52	23.9	± 7.0	46	38.1	± 6.2
81	14	22.2	± 1.5	11	35.9	± 2.3
86	70	22.6	± 6.7	52	35.4	± 6.5
95	7	28.0	± 2.1	3	40.7	± 2.2

of the larval stage and X is the temperature. The duration of the larval-plus-pupal stages decreased from 57.4 days at 68° to 35.4 days at 86°F. The regression equation for this period between 68° and 86°F is $\hat{y} = 0.00083X - 0.0387$ ($r^2 = 0.97$), where $\hat{y}$ is the reciprocal of the duration of the larval-plus-pupal stage in days and X is the temperature.

The life cycle of *A. parabates* was studied in a manner similar to that of *C. fernaldialis* except that moths were collected from a light trap. A single group of eggs required 6 days to hatch at 68°F. The duration of the larval and the larval-plus-pupal stages at 3 temperatures are given in Table 2. The regression equation for the larval stage is $\hat{y} = 0.00095X - 0.0385$ ($r^2 = 0.93$), where $\hat{y}$ is the reciprocal of the duration of the larval stage and X is the temperature. The regression equation for the larval-plus-pupal stages is $\hat{y} = 0.00080X - 0.0384$ ($r^2 = 0.93$), where $\hat{y}$ is the reciprocal of the duration of the larval-plus-pupal stages and X is the temperature. The equation for the larval-plus-pupal stages is almost identical to that for *C. fernaldialis*, so the two species develop at a similar rate and in a similar time.

TABLE 2. The mean duration of the larval and the larval-plus-pupal stages of *Albareda parabates* in relation to temperature.

Temperature °F	Larval stage			Larval-plus-pupal stages		
	No. individuals	Mean no. days	± SD	No. individuals	Mean no. days	± SD
68	11	40.9	± 6.7	6	66.8	± 7.0
77	10	27.0	± 4.0	10	39.1	± 3.7
86	10	24.1	± 5.0	10	34.0	± 3.6

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Behavior of *Vatesus* Beetles Associated with Army Ants

(Coleoptera: Staphylinidae)[1]

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In previous papers on staphylinid guests associated with army ants (Akre and Rettenmeyer, 1966), guests were separated into categories on the basis of their trail-following behavior and degree of host association. *Vatesus* were placed into the group having the closest possible relations with their host. Since then, more data has been obtained on the behavior of *Vatesus* beetles and is reported.

The tribe Vatesini contains only one genus and more than 25 species (Seevers 1965). All members are limulodid (horseshoe crab-shaped) in form, but differ from other Trachyporines in that they are associated with army ants. Discussion in this paper will be limited to the behavior of 3 species of *Vatesus* on which both field and laboratory data were collected.

Akre and Rettenmeyer (1966), in the first behavioral paper on staphylinids associated with army ants, discussed the behavior of the Aleocharinae, Paederinae, and Staphylininae, but omitted the Vatesini. The report also contained methods used in studying army ants and their guests.

Rettenmeyer (1961) includes an excellent discussion and much information on 6 species of *Vatesus* he collected with army ants in the

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